MEDIUM FOR ELECTROPHORESIS

FIELD OF THE INVENTION

This invention relates to electrophoretic media which are self supporting composite structures and a method therefor, the media comprising a polytetrafluoroethylene (PTFE) fibril matrix having liquid, electrically mobile ions, and particulate incorporated therein. In another aspect, a method of using the composite structures in electrophoretic separations is disclosed.

BACKGROUND OF THE INVENTION

Electrophoretic processes are known in the art and provide a means of separating, purifying, and analyzing mixtures.

Electrophoresis is an electromigration separation process based on differences in mobilities of electrically charged particles, solutes, or components of mixture in an electrical field. Species separated are generally charged. Neutral species can be separated if electroendoosmotic flow is present. Generally, there are two types of electrophoresis in use: moving boundary or "free" electrophoresis, in which separation takes place in free solution, and zone electrophoresis in which separation takes place utilizing solid supports. Electrophoresis is discussed in *New Directions in Electrophoretic Methods*, Phillips, Marwhall, Ed., American Chemical Society, Washington, D.C., 1987, pp. 1–20, and in *Electrophoresis*, Z. Deyl, Ed., G. Chromatography Library, Elsevier, New York, N.Y., 1979, pp. 1–37.

Presently, the most common type of electrophoresis is zone electrophoresis wherein certain solid or gel-type supports are used. The support serves as an anticonvection medium that limits free diffusion, and can aid the separation process through physical or chemical interactions with components of the mixture being separated.

Supports generally used in electrophoresis are solids such as paper and cellulose derivatives, and gels which are prepared from acrylamide, starch, agarose, and other materials. Gel electrophoresis is the most widely used form in this separation technique and finds application in analytical and preparative separation of proteins, nucleic acids, and other biological macromolecules. Several forms of gel electrophoresis in use include normal or native gel electrophoresis, denatured/sodium dodecyl sulfate (SDS) electrophoresis, isoelectric focusing (IEF) and immunelectrophoresis, as is known to those skilled in the art.

A conventional gel or gel slab for use in gel electrophoresis must be very thin to optimize speed, resolution, and to minimize localized heating. Thin gels, however, are very fragile and difficult to handle especially when concentrations of the gel material, for example, polyacrylamide, is low. Low concentration gels are necessary for separation of large (high molecular weight) molecules. However, these gels have little structural integrity.

To improve the mechanical stability and handling properties of such fragile gels, heretofor nonconductive support backings have been used. Unfortunately, these backings interfere with uniform transfer of heat generated from the electrical potential and from the resistance of the separation media and they cannot be used in electro-blotting experiments. Moreover, thin gels also

have very low sample capacity and are not useful for separations on a preparative scale.

Preparative gel electrophoresis can be performed on a bed of granulated swellable beads such as crosslinked polyacrylamide or other particulates such as crosslinked polydextrans. Preparation of the beds and isolation of products from them is laborious and time consuming. Further, the bed has very little structural integrity.

Composite articles comprising a polytetrafluoroethylene matrix with particulate enmeshed therein have been disclosed. U.S. Pat. No. 4,810,381 discloses a composite chromatographic article comprising a polytetrafluoroethylene (PTFE) fibril matrix and non-swellable sorptive particulate enmeshed therein. Other art disclosing polytetrafluoroethylene fibrillated matrix containing various particulate include U.S. Pat. Nos. 4,906,378, 4,871,671; 4,810,381; 4,565,663; 4,460,642; 4,373,519; 4,153,661; 3,407,249; and 3,407,096. Electrophoresis application is not taught or suggested in any of these references.

Processes for electrophoretic analyses are known. U.S. Pat. No. 4,006,069 discloses an electrophoresis process utilizing a supported analysis member comprising a porous polymeric flat plate and a polymeric gel enclosed in the open pores of the plate. Materials used include nonwoven fabrics. PTFE is not disclosed.

Japanese Patent No. 60-164,242 (English language abstract) discloses a process for a polyacrylamide gel film using a nonwoven polyester fabric. This process is also published in an article "Fabric Reinforced Polyacrylamide Gels for Electroblotting," in *Electrophoresis*, 6, 34–350, 1985.

Other patents of interest in electrophoretic applications include U.S. Pat. No. 3,922,432. This reference discloses a medium for a separation process prepared by bonding to the surface of a hydrated gel sheet a layer of discrete particles of a sorptive material. The particles themselves may be swellable so that they can become a continuous conductive medium for electrophoresis. U.S. Pat. No. 3,875,044 discloses a method of drying and adhering an electrophoresis gel to a polymer film backing and then precisely cutting sample wells into the gel. U.S. Pat. No. 4,657,656 discloses a method of increasing elasticity of polyacrylamide gels by adding a modifier such as glycerol to keep the gel elastic even when dry. U.S. Pat. No. 4,718,998 discloses a method of making a gel with an adhesive top and a thin polymer film overcoat useful for autoradiography. U.S. Pat. No. 4,722,777 discloses a method of making gels with improved adhesion to a polymer support backing using inorganic oxides in the adhesive.

SUMMARY OF THE INVENTION

Briefly, this invention provides a medium for electrophoresis comprising

(a) a polytetrafluoroethylene (PTFE) fibril matrix, and

(b) particulate, electrically mobile ions, and sufficient liquid in the interstitial spaces of said matrix to allow for ion transport,

the ratio of said particulate to PTFE being in the range of 99:1 to 4:1 by weight, and said ions being present in said liquid in an amount to provide a solution of concentration in the range of 1 to 1000 millimolar.

Preferably, the medium is self supporting. Particulate can be swollen or non-swollen; preferably it is a swollen gel which together with the liquid and ions fills intersti-